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Artificial intelligence in prenatal ultrasound: clinical applications and future perspectives

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Objective

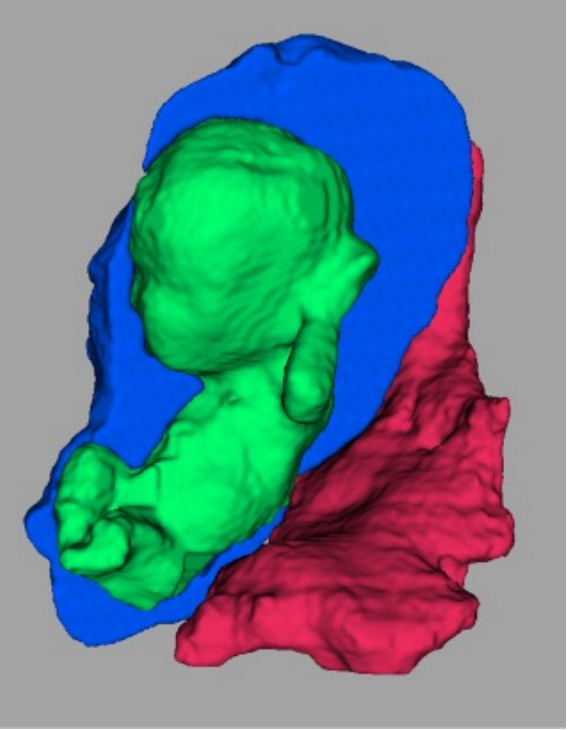
- Prenatal ultrasound (US) is the main imaging modality used to assess fetal anatomy and detect congenital anomalies.
- However, ultrasound examinations remain highly operator-dependent (figure 1).
- Artificial intelligence (AI) has emerged as a promising tool to assist image acquisition, automated measurements and anomaly detection.
- This review summarizes current evidence on the use of AI in prenatal ultrasound and its potential impact on clinical practice.

Methods

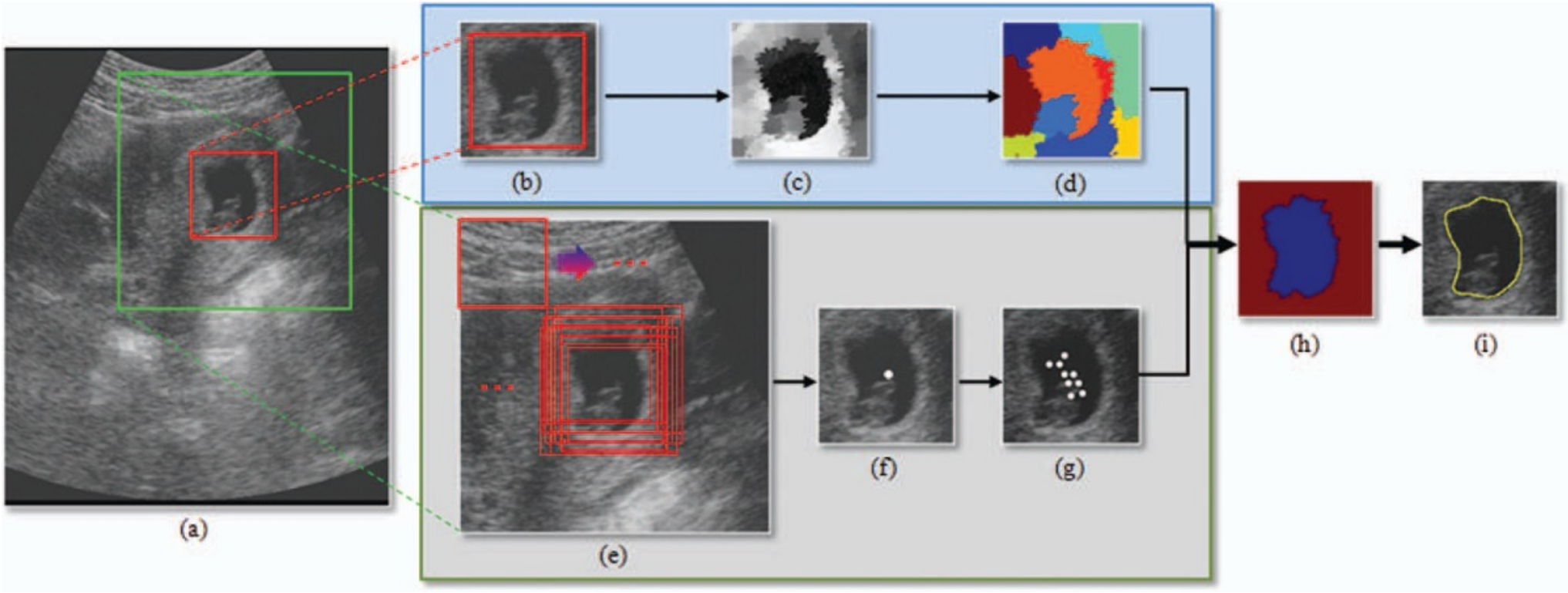
- A structured literature review was conducted using PubMed and MEDLINE databases.
- Recent studies evaluating AI, machine learning and deep learning applications in prenatal US were analyzed, focusing on automated plane recognition, fetal biometry, organ segmentation and anomaly detection.



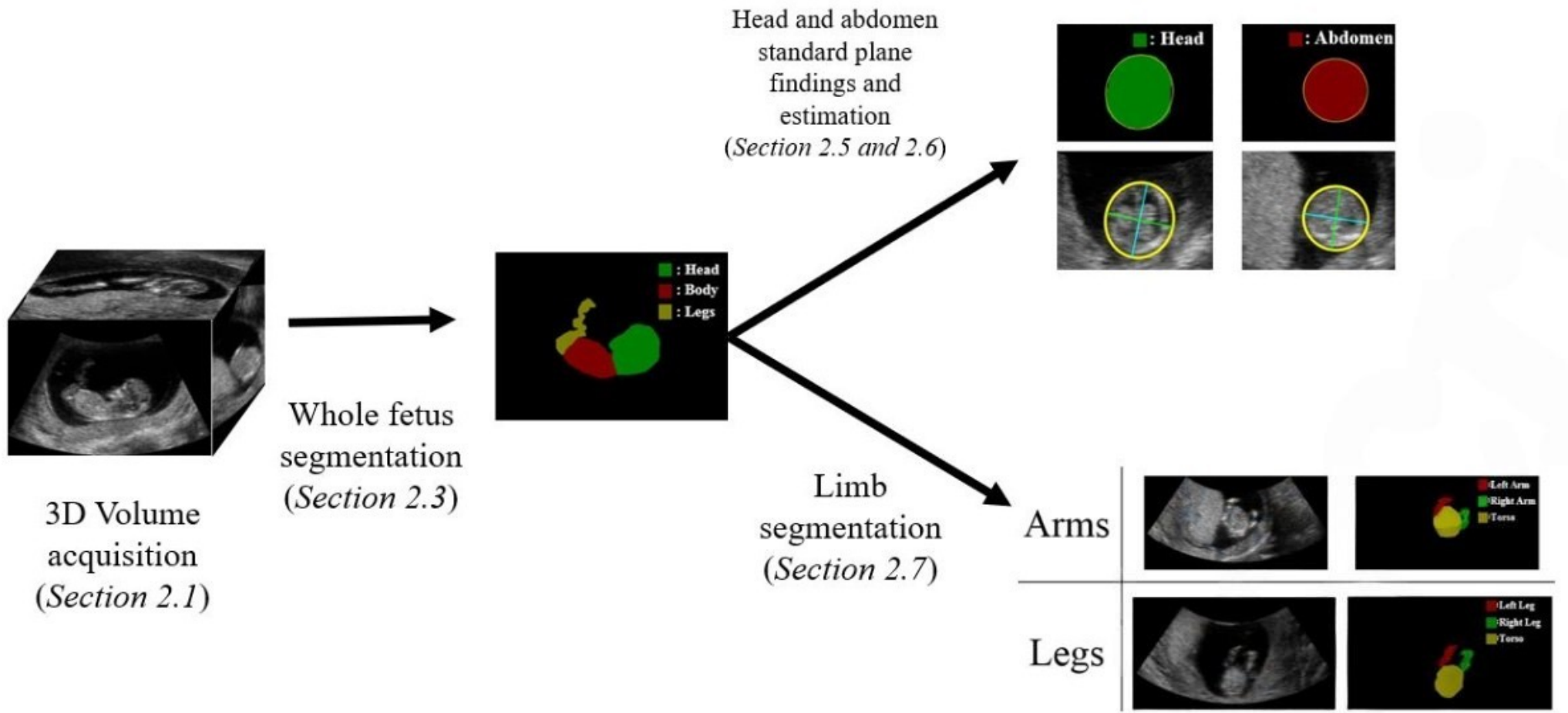
Picture 1. Ultrasound examination workstation. Historical image illustrating the clinical ultrasound environment from 1980s. Image: Linda Bartlett, National Institutes of Health (NIH), public domain, via Wikimedia Commons.



Picture 2. Automated semantic segmentation in prenatal volumetric ultrasound. AI-based dense labelling separates the fetus, gestational sac, and placenta within a 3D ultrasound volume. Adapted from Yang et al. (2019)

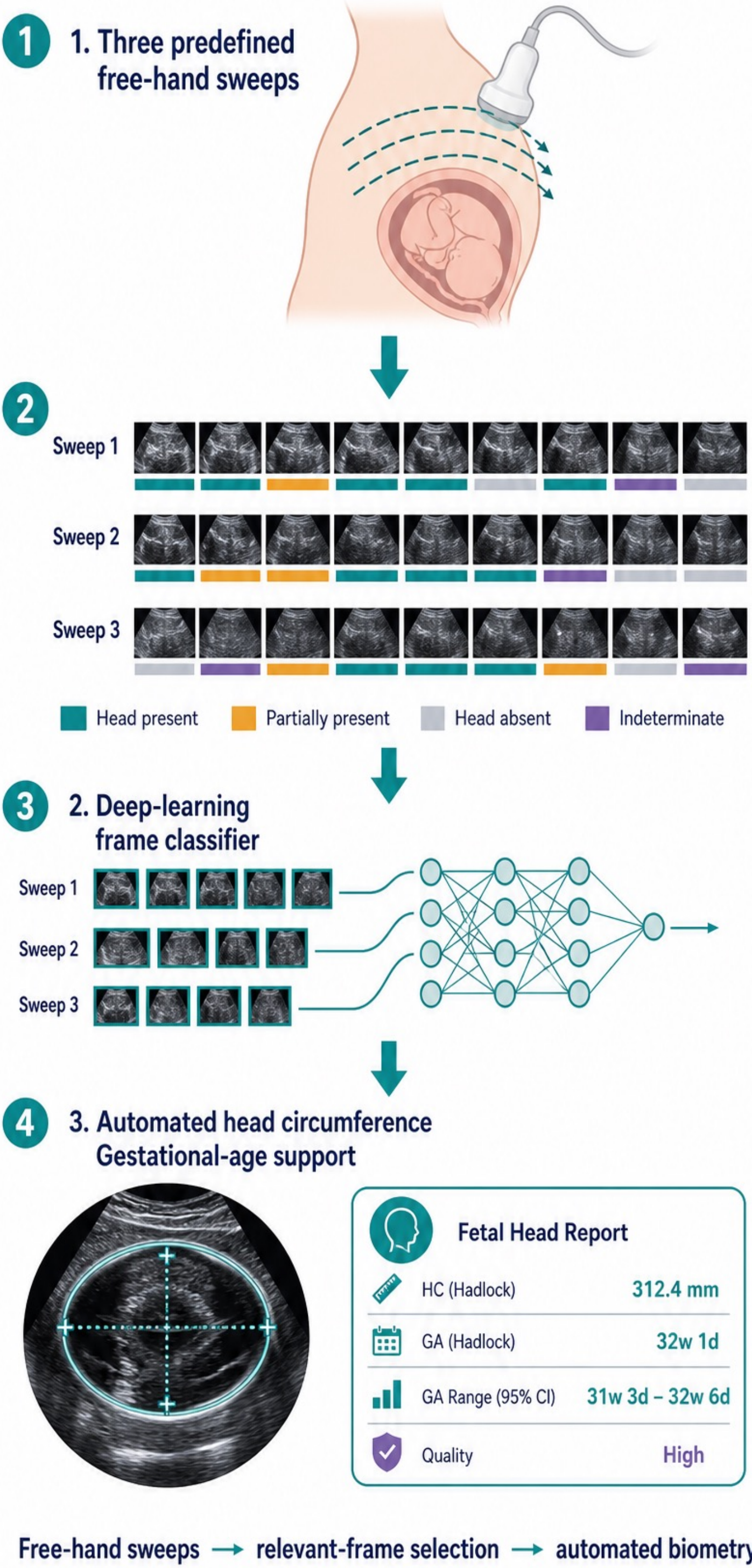


Picture 3. Automated selection of the gestational-sac standard plane and biometric measurement. The intelligent-scanning pipeline localises the gestational sac in routine ultrasound frames, selects an appropriate biometric plane, segments its boundary, and derives sac diameters. Reproduced from Zhang et al. (2012).



Picture 4. Automated first-trimester 3D fetal ultrasound analysis. From a single 3D ultrasound acquisition, AI can segment the fetus, identify standard biometric views, estimate biometry, and localise fetal limbs. Adapted from Ryou et al. (2019).

AI-BASED FETAL-HEAD FRAME RECOGNITION



Picture 5. AI-based fetal-head frame recognition from free-hand ultrasound sweeps. Three predefined transabdominal sweeps generate sequential ultrasound frames. A deep-learning classifier identifies frames containing the fetal head, enabling automated head-circumference estimation and gestational-age support. Illustrative workflow based on van den Heuvel et al. (2019).

Results

- Recent studies have demonstrated the growing role of AI in prenatal US imaging.
- Yang et al. developed an automated framework for semantic segmentation of fetal structures, including the fetus, gestational sac and placenta in volumetric US images (figure 2).
- Zhang et al. proposed automated identification of standardized biometric planes during routine US examinations (figure 3).
- Ryou et al. introduced an image-analysis method enabling visualization of key fetal anatomical structures and automated first-trimester biometry (figure 4).
- Furthermore, Van den Heuvel et al. integrated AI-based image analysis with the Hadlock growth curves, allowing automated estimation of gestational age from US biometric parameters (figure 5).
- He et al. also highlighted that deep learning algorithms can support plane recognition, fetal biometry and detection of anatomical structures, potentially improving diagnostic accuracy and workflow efficiency.

Conclusion

Artificial intelligence may improve prenatal ultrasound by supporting image analysis, standardizing measurements and facilitating earlier detection of fetal anomalies. Further validation studies are needed before clinical implementation.

Keywords: ultrasound, artificial intelligence, prenatal diagnosis

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